

# Millhouse Power Limited

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System Governance-Electricity Systems Team  
Department for Business, Energy and Industrial  
Strategy  
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27 September 2021

Dear Sirs,

## **Energy Future System Operator Consultation**

I am pleased on behalf of Millhouse Power Limited to provide our response to the above timely consultation. This response has also been shared with Ofgem.

We are encouraged that both BEIS and Ofgem are addressing what we believe to be vitally important matters in terms of the UK's ability to develop a future efficient, coordinated and economic energy system which is able to fully support the UK's 'net zero by 2050' ambition. We have provided a comprehensive response to the questions raised by the consultation from the perspective of an independent power systems consultancy. However, we would draw out three factors which we believe are key to any decision regarding the organisational and ownership structure of the Future System Operator, and the way in which the functions performed by National Grid today will be performed in future.

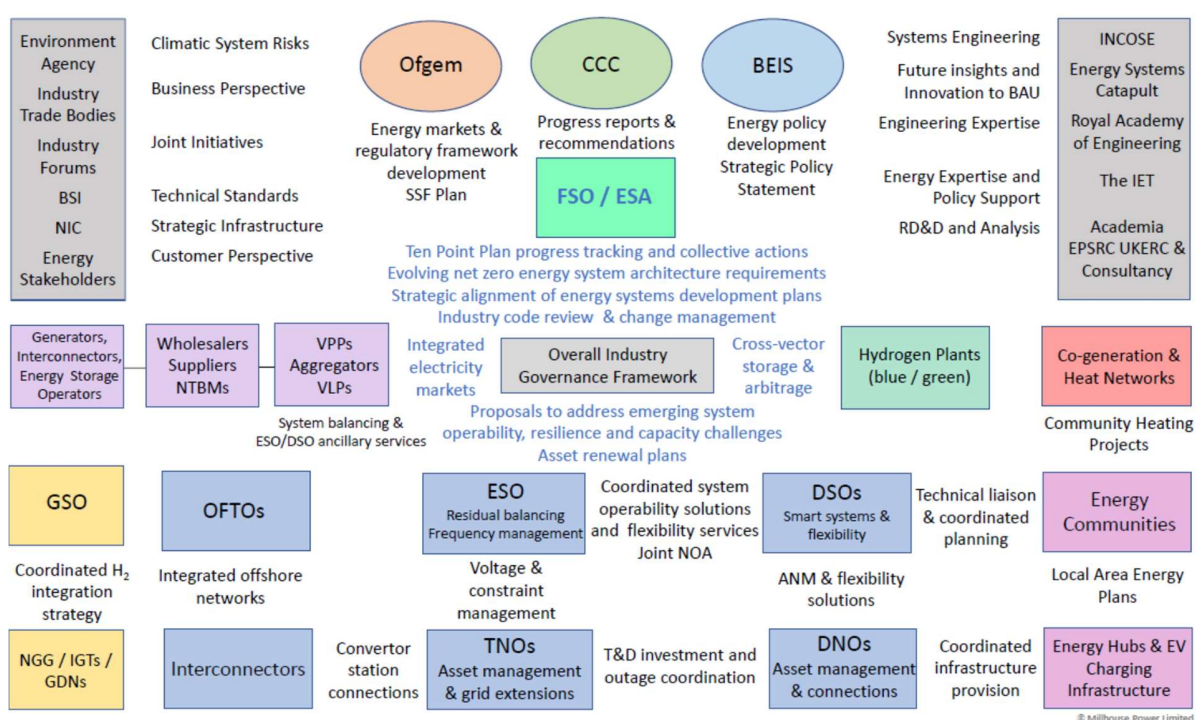
Firstly, the imperative in our view is to create an independent executive public body which will have responsibility for the strategic planning and coordinated development of UK's future energy system architecture. The role is essentially one of a 'Strategic System Planner' or 'Energy Systems Architect' (ESA) rather than a 'System Operator' (whose focus would naturally tend towards short-to-medium term horizons). As such, we would suggest that describing the role as 'Future System Operator' fails to convey the essentially strategic forward-looking nature of the role. Indeed, retaining responsibility for day-to-day system operations might prove to be an unhelpful distraction from the strategic planning function.

Secondly, electricity distribution networks are rapidly transitioning from 'passive' to 'actively managed' systems as a consequence of accommodating distributed energy resources (DERs) and in preparation for higher network demands due to electric vehicle charging and electrification of domestic heating. Much of this active management is conveying upstream benefits to the transmission system and to the day-to-day operation of the electricity system, including through securing ancillary services derived from DERs and grid-edge technologies through flexibility platforms. This gives rise to a need for greater integration of DNO/DSO, TNO and ESO functions, and a closer working relationship between these parties across both investment and operational planning timescales, and increasingly in real-time operations. In future this integration will need to extend to other energy vectors and cross-vector systems (including for example systems to exploit supply and demand-side energy arbitrage opportunities).

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Thirdly, given the inherent complexity of an integrated energy system with so many interdependencies and potential development pathways, the strategic planning function will need to embrace systems engineering principles to ensure coherence by design. Moreover, given the scale and pace of transition required for the UK's energy system, it will be necessary to also establish new agile governance arrangements which are sufficiently responsive to opportunity, and adaptable to change, to enable timely transition whilst ensuring the ongoing integrity of the energy system.

It follows from all the above that in terms of the relationship between the new FSO and the energy industry as a whole, creating the optimum 'organisational' structure will be of far greater importance than considerations of 'ownership' structure per se. In much simplified form, we would characterise the FSO/ESA's role, key relationships and interactions as follows.



In summary, achieving a net zero compliant integrated energy system will require radical changes in the way that UK energy policy is formulated, coordinated and delivered. The creation of an FSO as advocated by the consultation should be regarded as an important but interim step towards the more transformational changes outlined above and in our responses to the individual consultation questions in the following pages.

Yours faithfully,

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**1. Do you agree that net zero will create the need for new technical roles in the electricity and gas systems, and require a new approach to energy system governance?**

We agree that net zero is an unprecedented challenge for our economy and society which requires a step-change in whole energy system coordination and planning. We also agree that the transition to net zero will require a much more integrated energy system which will increase the complexity of operations and planning across all timescales in respect of both electricity and gas, and other energy-related vectors such as heat and transport systems. We agree too that this will require high quality whole system analysis and joined-up holistic thinking. This in turn creates the need for new and enhanced roles and functions based on a deep technical understanding of how energy system design and operation will need to evolve to achieve a successful low carbon energy system transition, consistent with delivery of net zero by 2050.

The IET / Energy Systems Catapult Future Power Systems Architecture (FPSA) programme <https://es.catapult.org.uk/capabilities/systems-integration/future-power-systems-architecture/> identified 35 new or enhanced functions for the electricity system alone that would be required by 2030: i.e. well before the 2050 'net zero' target date, and prior to subsequent more ambitious policy decisions such as those outlined in the Government's Energy White Paper and subsequent Ten Point Plan. These functions embrace the full spectrum of timescales from investment planning, through operational planning, to real-time. Hence, many of these functions would be relevant to an FSO (albeit we have views on the ideal scope of an FSO's role which we develop in our responses below). However, it is inconceivable that the current energy system governance structure would be effective in delivering these functions, or in embracing the new technical roles. The need for governance reform goes beyond energy *code* reform: the need is for governance arrangements that ensure the delivery of an efficient, coordinated, and economic whole (integrated) energy system. The governance framework will need to address each energy-related element of the Government's Ten Point Plan, tracking progress and quickly initiating any required recovery actions. Indeed, the Ten Point Plan itself will need to be periodically reviewed in light of experience and progress to ensure it remains consistent with the objective of achieving net zero by 2050 efficiently and economically.

**2. Do you agree that the establishment of a Future System Operator is needed to fulfil the kinds of technical roles needed to drive net zero?**

There is a need for a new independent body able to effectively undertake an overarching strategic role in ensuring the economic development and continued technical integrity of the whole energy system. Whilst the role should not be a 'central planner' per se, Ofgem's foreword to the consultation rightly cites the need for more effective *strategic* planning, management, and greater coordination across the energy system, providing independent advice to Government and Ofgem (and other relevant bodies and organisations such as CCC) and potentially other regulators (including NIAUR and any future body with responsibility for energy system regulation – for example heat networks). BEIS' foreword to the consultation also correctly notes that the new body would need to be accountable to consumers and ultimately citizens, and resilient to operational challenges (and responsive to operational opportunities) over the short, medium and long-term.

We agree this future body would need to be excellent in terms of technical expertise and operational capability, but also in terms of development and integration of energy markets which are able to fully exploit technological capability in developing an efficient, coordinated, and economic whole

(integrated) energy system for the ultimate benefit of customers. In short, we believe the required role is that of an 'Energy Systems Architect' (ESA) rather than a 'System Operator' per se. The ESA would not be directly responsible for all 35 of the new and enhanced functions identified by the Future Power Systems Architecture programme; rather its role would be to ensure functional coordination, compatibility, and energy system interoperability, including the integration of emerging technologies delivering new functionality to the energy system.

It is important to note, however, that this role must extend to the whole energy system, including (especially for electricity) those parts of the infrastructure beyond the boundary meter, including distributed energy resources. The consultation correctly states that the gas and electricity 'system operators' have a unique position at the heart of their respective systems and that this role also gives them unparalleled insight into how each system operates and relationships with other energy companies. However, it is important to understand that the bulk of the electricity (and gas) system is operated by DNOs and GDNs<sup>1</sup>. Moreover, particularly in the case of DNOs, their system operations are necessarily becoming increasingly active (rather than passive) as a consequence of the challenges and opportunities presented by distributed energy resources. This has created a need to apply active network management solutions and exploit accessible flexibility in order to manage system power flows and ensure quality of customer service is continuously improved. This transition from DNO to DSO is creating a much stronger relationship with their connected customers (demand, generation, and battery energy storage) and with local area energy initiatives. This gives rise to a need for stronger whole system coordination. Throughout the remainder of our response to this consultation we shall refer to an 'FSO/ESA' better reflecting in our view the nature of the role we believe is required.

**3. Do you agree that a Future System Operator should have roles in both the electricity and gas systems?**

Coordination and functional optimisation across all energy vectors (not only electricity and gas) is essential to the development and ongoing management of an efficient, coordinated, and economic whole energy system. For example, this would include exploiting opportunities for supply and demand-side arbitrage across energy vectors, including electricity, gas, and heat, but also extending to low carbon transport and both short and long-duration energy storage (in all forms). However, as highlighted in our response to question 2, it would be a serious oversight to assume that National Grid has sole (or even the major) responsibility for electricity (or gas) system operation. It follows that, from a strategic planning and coordination perspective, any future FSO/ESA role must embrace the whole of the energy supply chain (including beyond the boundary meter) for each energy vector, and also the interaction between energy vectors which in future will become an increasingly important aspect of whole energy system coordination and optimisation across all timescales.

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<sup>1</sup> For example, approximately 97% of UK's onshore electricity network infrastructure (in terms of aggregate route length) is owned and operated by DNOs.

#### **4. Do you agree that a Future System Operator should be entirely separate from National Grid plc?**

In our view, the more strategic FSO/ESA functions should be separated from National Grid. These functions might reasonably include taking over responsibility for publishing existing documents which provide a longer-term perspective such as: Electricity and Gas Ten-Year Statements and Future Energy Scenarios. The Annual Electricity and Gas Winter and Summer Outlook reports and System Operability Framework reports would logically remain an output from National Grid (acknowledging that the SOF report is based on FES scenarios). We would however suggest that the FSO/ESA should also be responsible for an annual Statement of System Performance and an Assessment of System Health (as proposed by the consultation) but also an annual Net Zero Transformation Progress Report which would provide an insight into progress against targets in delivering a net zero compliant energy system, along with identified risks and proposed mitigation measures. The FSO/ESA would take over the 'delivery body' function for the Capacity Market whilst having a greater role in the design of energy markets more broadly.

However, the case for removal of responsibility from National Grid for real-time system balancing and dispatch of ancillary services, and instead assigning these functions to a new FSO/ESA, is less compelling. As the consultation acknowledges, whilst conceptually there may be potential conflicts of interest in terms of some of National Grid's responsibilities (for example the NOA process) in practice there is little evidence of vested interests influencing decisions on system operation, and such potential conflicts could in any case be managed through effective regulation. Indeed, we would cite National Grid's NOA Pathfinder projects (High Voltage, Stability, and Constraint Management) as examples of how National Grid is engaging with solution providers to develop innovative new ways to operate the electricity system, relying less on traditional 'in-house' solutions or assets, or 'mandated' services.

A further important consideration (acknowledged by the consultation but given little further consideration at this stage) is the role of DNOs and their transition to DSOs. This transition needs careful coordination between existing ESO and DSO functions (which the ENA Open Networks project is actively considering from an ancillary services perspective) for example in maximising the benefits of flexibility from a whole system (i.e. full-chain flexibility) perspective. Full consideration needs to be given to the implications of DNO-DSO transition and the extent (if any) to which independent DSOs might emerge. For example, in its RIIO-ED2 Draft Business Plan, UK Power Networks has proposed the establishment of an IDSO. Albeit under the same ownership group as the regulated DNO business it will have its own advisory board and business measures which will be reported separately to stakeholders and Ofgem.

It follows that real-time system (residual) balancing and dispatch of ancillary services will need to become far more closely coordinated with DSOs who will also be operating their (distribution) systems closer to real time through Advanced Distribution Management Systems (for example dynamic inter-circuit sharing of power flows and integrated voltage management systems) and through real-time dispatch of flexibility-based ancillary services. Whilst the consultation acknowledges that the development of markets and products for system balancing and ancillary services must be closely aligned to emerging real-time challenges and opportunities (a development role which might reasonably be performed by an FSO/ESA) it is questionable whether that in itself is sufficient justification to assign the real-time and operational timescale planning control centre functions to the new FSO/ESA.

A net zero compliant electricity system will give rise to an increasing need for coordination between ESO and DSOs. Examples include: coordination of dispatch of flexibility-based ancillary services; network outage and contingency planning; and (in the event of a national system shutdown) successfully achieving a system black-start. Retaining responsibility for these functions between ESO and DSOs as regulated businesses would therefore seem preferable. For these reasons, there would seem to be some merit in retaining real-time electricity system operation and residual balancing (and responsibility for issuing Electricity Margin Notices) as a regulated function (undertaken by ESO and DSOs) rather than an activity assigned to an FSO/ESA outside the jurisdiction of Ofgem.

It might also be questioned whether the responsibility for day-to-day (indeed second-by second) operation of the electricity system might prove to be a distraction from the more strategic roles proposed for the FSO/ESA such as: applying whole-system oversight to the strategic planning and coordination of the whole energy system; providing independent impartial technical advice to Government and Ofgem; and taking on a greater role in the design of integrated energy markets that support the optimisation of inter-vector actions across investment and operational planning timescales, and in real-time.

In summary, whilst we have no strong view on whether *ownership* of the current ESO function should be separated from the ownership of National Grid's TNO business, we see no compelling reason for initiating such separation (similarly we would see no compelling reason to separate *ownership* of DSO functions from the DNO businesses). The current *business* (and licence) separation between NGESO and NGET should however continue. We do however believe that the new FSO/ESA should be separated from National Grid and established as an executive independent corporate body within the public sector. We expand on this in our response to question 14.

**5. What issues are there with existing institutional arrangements in the UK energy system in relation to system-wide decision-making and planning?**

The Future Power Systems Architecture programme has identified a number of institutional issues including:

- The absence of 'whole energy system' thinking ('whole system' is all too often cited in the context of electricity only – or even limited to 'T&D' without consideration of the role of other vectors or assets beyond the boundary meter);
- Short-termism, partly as a consequence of a regulatory framework for networks which is based on five-year review periods with incentive mechanisms which tend to prioritise outputs and deliverables within a single review period over those which might deliver longer-term benefits;
- The institutional barriers inherent within the current governance arrangements to innovation and wider stakeholder access to debate and decision making;
- Governance arrangements which are inherently bureaucratic, inflexible and insufficiently agile to respond to the scale and pace of change required to deliver a net zero-compliant energy system.

Notwithstanding the above, the most fundamental issue relating to system-wide decision making and planning is the absence of an Energy Systems Architect with responsibility for providing advice to



Government and overall industry direction regarding the development of an integrated net zero-compliant whole energy system for the UK. Note that: the requirement for 'integration' applies across all related vectors and their relationship to each other; 'development' must extend not only to technologies but also to developing compatible energy markets; and 'whole system' must include the whole of the energy supply chain, including grid-edge assets owned by customers.

**6. What examples/case studies are you aware of where net zero delivery in one part of the energy system did not adequately account for cross-system impacts or costs?**

We are aware of a number of examples where insufficient coordination across elements of the energy system might lead to missed synergies, resulting in inefficient costs.

**Hydrogen** - The current debate over the future of hydrogen and its production technology options (essentially blue or green hydrogen, ignoring other less developed or less environmentally friendly options) appears not yet to recognise the full implications for the future electricity system. For example, considerations over the relative economic case for green over blue hydrogen (the latter being currently perceived as both more accessible and less expensive) generally ignore the need both for longer-term energy storage and an 'energy sink' in a future power system with high levels of renewables. There will be occasions (as studies have shown) with consecutive days of very low wind generation production, but also sustained periods where wind generation output will exceed electricity demand (and hence potentially extended periods of generation curtailment with both high constraint payments, and negative pricing). The ability to switch electricity production from supplying demand to producing hydrogen through electrolysis at times of high electricity production / low demand could deliver significant electricity system efficiencies, while the production of green hydrogen from surplus wind generation output might also provide an effective means of energy storage. This will be an important consideration in the context of the Ten Point Plan ambition of 40GW of offshore wind generation capacity by 2030.

In summary, the relative economics of green and blue hydrogen production (the latter including the cost of CCUS) need to be evaluated from a long-term 'whole energy system' perspective. Notwithstanding economic comparisons, an IET report<sup>2</sup> has highlighted the engineering risks and uncertainties associated with the large-scale deployment of delivering hydrogen to homes and businesses through the repurposing of the natural gas network. Moreover, given that blue hydrogen will inevitably play a major role for large-scale retrofit deployment to industry, homes and businesses, at least in the more immediate future, the report also notes the need for simultaneous deployment of CCUS infrastructure.

**Offshore Networks** - A further example is the current lack of an integrated approach for the deployment of offshore networks. A recent IET study has discovered there are at least 50 high-profile industry initiatives with over 500 participants in various interest groups, and a significant number of

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<sup>2</sup> <https://www.theiet.org/impact-society/factfiles/energy-factfiles/energy-generation-and-policy/transitioning-to-hydrogen/>

smaller, particular interest or localised parallel initiatives<sup>3</sup>. Of these initiatives, there are 16 key groups actively progressing offshore network integration. There is surprisingly little overlap between these groups. Informing the wider stakeholder group, illuminating the synergies and opportunities for better integration, must be a priority. We expand on this in our response to question 12.

**Smart EV Charging** - By way of a more immediate example, whilst we acknowledge progress is being made through various innovation projects, the case for decarbonisation of transport has yet to fully identify the potential synergies between the electricity system and battery electric vehicle (BEV) charging (or discharging). It will be essential that the recommendations of the EV Energy Task Force<sup>4</sup> in respect of smart charging functionality and commercial interoperability are fully implemented, and this in turn is dependent on completion of the smart meter rollout programme and the implementation of half-hourly settlement to replace settlement based on super-customer profiles. Failure to implement these recommendations will lead to higher costs of operating BEVs and missed opportunities in terms of efficient operation of the electricity system.

**EV Charging Infrastructure** - Related to the transition from ICE vehicles to BEVs, the ban on sales of new ICE cars and vans from 2030 will require major investment in public EV charging infrastructure to cater for those who regularly make long journeys, but especially for those households with no access to off-street parking and charging facilities. Whilst it might be reasonable to assume that the strategic road network will be reasonably well equipped with rapid charging facilities, there is likely to be a much weaker incentive for charge-point operators to cater for inner-urban and rural areas. Moreover, without effective national and local coordination in the rollout of public EV charging facilities, there are likely to be some areas of the UK with over-provision, but many areas with a serious under-provision of public EV charging infrastructure. This is likely to lead not only to inefficient costs of providing public EV charging infrastructure, but also in terms of inconvenience costs to BEV (or prospective BEV) owners. Regional deficiencies in public EV charging infrastructure might also have adverse impacts on the Government's levelling-up agenda. Again, it will be essential that the recommendations of the EV Energy Task Force in respect of effective planning and coordination of infrastructure are fully implemented.

**Full-Chain Flexibility** - flexibility is now rightly regarded as a core enabler of an electricity system served by an increasing contribution from weather-dependent generation, and new sources of electricity demand (such as EV charging) that are inherently flexible in terms of when demand is taken. However, ensuring optimum application of flexibility through a coordinated, integrated and transparent liquid market will be key; this extends to cross-vector sources of flexibility derived from supply and demand-side arbitrage. Albeit efforts to coordinate procurement of flexibility between ESO and DNOs for ancillary services are in hand through the ENA Open Networks project, there are other (potentially more important) drivers for flexibility, including closer to real time alignment of demand with available output from zero marginal cost renewable generation. Whilst smart meters

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<sup>3</sup> <https://www.theiet.org/impact-society/factfiles/energy-factfiles/energy-generation-and-policy/offshore-energy-infrastructure-landscaping-uk-and-neighbouring-waters/>

<sup>4</sup> <https://evenenergytaskforce.com/reports/work-package-one/>



and new dynamic retail tariffs might play an important role here, the Balancing Mechanism Wider Access arrangements are now encouraging Aggregators acting as VLPs to access flexibility from half-hourly settled domestic customers with smart EV chargers. It is also conceivable that in future smart EV chargers might also be able to provide frequency response services. However, other than through individual Aggregators' platforms, there is currently no overarching consideration of potential synergies and conflicts between, Balancing Mechanism services and ESO/DSO ancillary services, or tariff price signals. What is required is a coordinated full-chain approach to flexibility such that it delivers the maximum 'whole system' value at any given time.

**7. Where should Government focus in our efforts to improve systems thinking and coordination across the energy system?**

Again, referencing the Future Power Systems Architecture programme recommendations, the immediate focus for Government should be towards developing 'systems engineering' capability, wherein highly complex interactions and interdependencies between elements (e.g. of a rapidly evolving whole energy system) are evaluated in a way which simple incremental evolution of an existing design is unable to achieve. Systems engineering capability would logically reside within an 'Energy Systems Architect' role where responsibility would also lie for ensuring the economic development and continued technical integrity of the power system and the wider integrated energy system. An Energy Systems Architect would not prescribe (technological or market) solutions but would apply systems engineering principles to address emergent issues, including through exploiting evolving technological and commercial innovation to ensure new opportunities are integrated within the overall high-level design of the energy system. This in turn would pave the way for solution providers to develop innovative technological and/or market products. Implementation would be through a new industry governance framework, preserving whole system integrity and interoperability, and maximising optimisation of low carbon energy resources.

**8. Do you agree that the FSO should undertake all the existing roles and functions of NGENSO? If not, please explain why.**

The focus should be towards considering and fully evaluating the new or enhanced functions required of (what Ofgem cites as) the FSO role (i.e. the roles and functions necessary to deliver an efficient, coordinated and economic whole-energy system) rather than on the existing roles and functions of NGENSO. As stated in our response to question 4, the case for assigning the responsibility for real-time system operation (i.e. the control centre functions) to the FSO/ESA needs to be carefully considered - holistically (rather than ideologically) - taking account of the future (yet to be fully defined) role of DSOs (including potentially IDSOs). In order for the electricity system to be operated as an efficient, coordinated and economic 'whole' system, the imperative is to ensure coordination of operations across transmission (both onshore and offshore) and distribution systems extending to 'beyond the boundary meter' assets (demand, generation and energy storage).

The real-time operation of distribution systems is becoming increasingly reliant on active management of both distribution assets through advanced distribution management systems (ADMS) and distributed energy resources through distributed energy resource management systems (DERMS). It follows that at distribution system level, 'operations' and 'asset management' functions are becoming increasingly interdependent and largely inseparable. Moreover, coordination between DNO/DSO and the current NGENSO control centre functions is becoming increasingly important. At

least one innovation project (National Grid / UK Power Networks Power Potential NIC project<sup>5</sup>) in the south-east of England has established an ICCP link (using a real-time data exchange inter-control centre protocol) which provides real-time measuring data between National Grid's and UKPN's control centres in order to enable data exchanges across operational planning timescales and in real-time. This ensures robust contingency planning and enables constraints on generation export to be minimised by managing reactive and real power flows across T&D boundaries. A further 59 additional sites have been identified where this approach could be applied. This is just one example of how interactions between transmission and distribution systems are becoming more integrated and facilitating an essential aspect of electricity system operation. Other examples established through coordinated innovation projects include:

- CLASS (ENWL)<sup>6</sup> which uses conventional distribution assets (primary substation transformers and tap-changers) to provide a range of ESO ancillary services including frequency response, demand reduction (or boost), and reactive power absorption to address high overnight transmission system voltages.
- 4D Heat (SSEN)<sup>7</sup> which has investigated the potential for relieving a transmission boundary constraint to generation export by shifting demand on the distribution system in order to more closely align demand import and wind generation export profiles.
- Distributed ReStart<sup>8</sup> (ESO and SPEN) which is exploring the potential for a black-start procedure to be initiated from the distribution system (i.e. bottom-up rather than top-down).

It is therefore questionable whether responsibility for the current ESO control-centre functions should be transferred to the new FSO/ESA. The strategic responsibility for developing increasingly complex and integrated (whole) electricity system functionality does not seem consistent with this and may even be a distraction from performing the essential roles surrounding longer-term strategic development of the whole energy system. This would include for example: identifying optimised decarbonisation pathways in terms of contributions from heat, transport, hydrogen and CCUS (and CO2 transportation); ensuring coordinated energy market development; overseeing engineering standards and energy code development; and supporting decisions by Government, Ofgem and other organisations, including through delivery of the Strategic Policy Statement.

A further key function relates to local energy mapping and planning. Whilst we would see this as a future core function of a DSO (in conjunction with GDNs and Local Authorities) due to the very localised nature of local area energy planning, we would nevertheless see the FSO/ESA providing an overarching strategic perspective on how well local area energy plans fit together from a national

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<sup>5</sup> <https://www.nationalgrideso.com/future-energy/projects/power-potential> (see for example the 'Understand the Power Potential project in 2 minutes' video)

<sup>6</sup> <https://www.enwl.co.uk/go-net-zero/innovation/key-projects/class/>

<sup>7</sup> <http://news.ssen.co.uk/news/all-articles/2020/may/surplus-wind-power-could-heat-scottish-homes-in-new-project/>

<sup>8</sup> <https://www.nationalgrideso.com/news/distributed-restart-making-it-possible-reboot-britains-grid-through-low-carbon-tech>

perspective and to what extent best practice is being shared and implemented. An example of this would be ensuring the coordination of public EV charging infrastructure where several reports, including reports issued by the EV Energy Task Force have highlighted the need for strategic oversight.

These are the essential functions of an FSO/ESA but, in terms of real-time operations of the electricity system, the primary imperative is for the current ESO and DSO control centre functions to be more closely integrated with seamless exchanges of data for real-time operations and operational planning. This would not preclude the FSO/ESA accessing the necessary information (facilitated by increased digitalisation of energy system data) to inform their strategic energy system development role. Nor would it inhibit any of the other FSO roles cited in the consultation, for example having access to time-series system balancing data for effective energy system planning, and also having visibility of network loading and capacity data to help identify emerging constraints and trends. Indeed, an arms-length relationship with electricity system control centres and asset managers is likely to be more conducive to 'bottom-up' innovation (such as the examples cited above) which will enable the FSO/ESA to continuously support the development of rules, codes and standards that remove barriers to new technologies, market developments and business models, and to identify areas where new technology and/or market mechanisms are needed, and where innovation stimulus might be necessary.

On that basis, as proposed for the gas system, our recommendation is that the FSO/ESA should undertake strategic network planning, long-term forecasting, and market development functions, but not real time system operation and balancing and associated functions.

**9. Do you agree there is a case for the FSO to undertake the gas strategic functions outlined in Option 1? Please elaborate and provide any views on the functions we have outlined.**

The future FSO/ESA role needs to embrace all energy vectors – particularly those which provide supply and demand arbitrage opportunities (this includes options for hydrogen production, integration and utilisation as outlined in the response to question 6); this should further extend to local energy coproduction and distributed heat systems. The effectiveness of a systems engineering approach to the evolution of the energy system depends fundamentally on having oversight of all energy-related strategic functions.

**10. Do you agree that there is not currently a case for the FSO to undertake all GSO roles and functions, including real-time gas system operation, as outlined in Option 2? If you do not agree, please explain why.**

The case for transferring all GSO roles is not compelling but, as discussed above, neither is the case compelling for transferring all ESO roles to the FSO. It ultimately depends on defining the full scope of roles and responsibilities for the FSO/ESA, and the extent to which the (essential) Energy Systems Architect role is embraced by the FSO/ESA.

**11. Do you have views on the proposal for an advisory role? What organisations do you consider would benefit from the provision of advice by the FSO? Who should bear the costs of providing that advice?**

An advisory role as described in the consultation is a key deliverable (but again, more logically a deliverable of an independent Energy Systems ‘Architect’ rather than an Energy System ‘Operator’). An ESA advisory role would include, inter alia ...

- recommending when market interventions to achieve a strategic objective might be called for (or equally, when an intervention should be scaled down or discontinued);
- recommending appropriate changes to regulatory policy where regulatory barriers might unintentionally impede progress;
- identifying the need for innovation and/or stimulus in specific energy-related areas, including both technology and market innovation;
- highlighting risks to the timely achievement of a net zero compliant energy system and advising on required enabling actions or interventions;
- highlighting emergent risks to energy system security across all vectors and proposing mitigating actions; and
- advising on risks to the energy (especially electricity) system arising from climate change, including potentially more frequent and severe storms and flooding.

It follows that policy makers, entrepreneurs, energy infrastructure providers, and energy stakeholders generally would benefit from advice from the FSO/ESA (albeit we would think of it more as mutual interaction and sharing of knowledge). The illustration in our covering letter provides an insight into the sort of organisations that would benefit from such interaction.

**12. Do you have any views on the other areas where we are considering new and enhanced roles and functions for the FSO (outlined in section 3.2)?**

We agree that the FSO/ESA should have roles in the following areas:

- Providing independent advice to Government and Ofgem – for example in regard to energy policy, energy system development, and infrastructure investment plans.
- Strategic oversight of energy system planning and network development – this should extend to strategic rollout of public EV charging infrastructure and heat networks.
- Energy market design – in order to create an effective coordinated whole energy market which incentivises the optimum arbitrage between energy vectors and full-chain flexibility of demand and energy storage.
- Ensuring coordination between and with energy transmission and distribution networks (this would include heat networks, hydrogen, and offshore electricity transmission and interconnectors) in order to create an optimised whole energy system.
- Heat and transport decarbonisation – optimising options surrounding electrification and hydrogen, with consideration to the energy arbitrage opportunities between these vectors – including for example production of green hydrogen through electrolysis using surplus wind

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generation at times of low electricity demand and creating a source of long-duration energy storage.

- Oversight of future energy system operability, engineering standards and energy code development in the role of an Energy Systems Architect that is able to continuously evaluate whole energy system pathways (e.g. towards a net zero energy system) with regard to continuously emerging challenges and opportunities (but not prescribing solutions per se).
- Evaluating opportunities around Hydrogen and CCUS from a technical and economic perspective.

We believe, however, there are other essential roles for an FSO/ESA; these include the following:

- Maintaining a comprehensive whole energy system risk register – which would be continuously reviewed to identify and quantify emerging threats and opportunities (from both a probability and impact perspective) along with effective mitigation measures. A particular focus would be to identify both risk and effective mitigation in respect of ‘high impact low probability’ events. This would include, inter alia, risks in respect of cyber security, telecommunications infrastructure, climate change (resilience of infrastructure to effects of global warming) and potential human skills and material resource shortages. A further risk to be considered (and highlighted by recent events) is that of availability of primary fuel sources, including natural gas which will be a vital component of UK’s energy mix at least over the medium-long term.

With regard to climate change, whilst the objective of net zero is to limit global temperature rise, it is widely acknowledged that some effects are now irreversible and are likely to lead to more prolonged and severe weather events. Changes in the Jet Stream will affect wind patterns at sea level and could lead to ‘weather-blocking’ events which (for example) could result in prolonged periods (several days) with minimal output from wind generation. Meanwhile, a weakening Gulf Stream could lead to colder winters and hence higher demands for (increasingly electric) space heating. The former has important implications for supply security and suggests the need for a comprehensive strategy in developing long-duration energy storage solutions. Notwithstanding implications for supply security, more frequent and severe weather events have implications for electricity network reliability, and it will be important to assess the need for improved storm resilience for overhead transmission and distribution lines, and improved flooding mitigation measures for vulnerable substations.

- Identifying priority areas for innovation across the full ‘technology readiness’ spectrum from TRL1 to TRL9. This would include liaison with appropriate global industry and academia research organisations and the Energy Systems Catapult; identifying entrepreneurs; and recommending specific calls for innovation and appropriate funding mechanisms. Coordination of innovation to build on synergies would be key, as would identifying where promising innovation has progressed to a given TRL but has stalled due to lack of resource.
- An ESA would play a key role in energy code governance as an independent ‘non-vested interest’ party with a long-term integrated whole energy system perspective. This will be essential in ensuring a progressive, cost-effective and agile system of energy industry governance that is able to retain focus on whole energy system coordination and integration whilst responding quickly to emerging challenges (for example identified by the above-mentioned risk register) and opportunities (for example emergence of new technologies).

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- Overseeing a more integrated approach to the deployment of offshore networks as a key infrastructure enabler for net zero. A recent IET study has identified that most offshore energy system stakeholders have very limited visibility of the multiple facets of the challenges we face in delivering targets for offshore wind, interconnection, carbon capture, hydrogen production, and marine energy projects. The report highlights issues around multiple users, co-ordination challenges, conflicting parallel regulations, regional imbalances, and the need to develop co-ordinated plans at pace while maintaining momentum of current activities. The report concludes that without clear co-ordination (market, regulatory, stakeholder, economic etc.) the opportunity to maximise the benefits of all existing and emerging technologies in the transition to net zero, will be constrained<sup>9</sup>.
- Bringing a 'systems engineering' perspective to the continuously evolving architecture of the whole energy system to minimise the risk of suboptimal or stranded investments through a comprehensive understanding of interactions and interdependencies between elements of the whole energy system, and of the relative benefits and risks of alternative pathways.

**13. What are your views on our proposed characteristics and attributes of a future system operator and how the models presented would deliver against them? Are there other characteristics or attributes that we have not yet considered?**

The consultation cites: providing independent advice; more direct planning of onshore and offshore electricity networks; the introduction of competition in network solutions; and a more active role in designing and planning the future energy system as characteristics of an FSO. Whilst we would broadly agree with that, this appears to overlook the wider FSO/ESA characteristics (or roles) which will be necessary to deliver a net zero compliant energy system, for example as described in our response to question 12. However, there is a need to consider functionality across investment planning, operational planning, and real-time scales. The interactions and interdependencies between the electricity system and other energy vectors will need to be comprehensively understood and the design of the energy system optimised from a whole energy system perspective. This includes supply and demand-side energy arbitrage between vectors (for example co-generation and hybrid heating systems) and also the integration of both short and long duration energy storage. The future practicality and economic scope of green hydrogen production and its role both as a source of green fuel (for example for HGVs) and as a means of optimising the electricity system (i.e. as both an energy storage source but also as a means of utilising surplus offshore wind generation in real-time through using the energy to supply electrolysis plants) will be essential to the economic development of a future net zero-compliant energy system.

Moreover, the need is to consider not only technology optimisation and integration but also market integration; in particular the alignment of technologies and markets such that the most efficient use and application of energy resources at any given time (both from a short and long-run marginal cost perspective) is incentivised. The evolution (or emergence) of technology needs to be matched by a

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<sup>9</sup> <https://www.theiet.org/impact-society/factfiles/energy-factfiles/energy-generation-and-policy/offshore-energy-infrastructure-landscaping-uk-and-neighbouring-waters/>



corresponding evolution of markets. On the one hand this should help avoid scenarios witnessed recently of excessively high day-ahead auction electricity prices and spikes in system balancing costs. On the other hand, it should help avoid uncomfortably tight electricity system margins and/or high risks of frequency instability due to a combination of low system inertia and insufficient (or excessively priced) frequency response (e.g. dynamic containment) services. In this respect, we have some concerns over the universal 'flexibility first' strategies being pursued in isolation by DNOs (encouraged by Ofgem). Whilst we acknowledge that the ENA Open Networks programme is seeking to improve coordination between ESO and DSO flexibility in performing ancillary services (such as STOR, frequency response and constraint management) it is unclear how the potentially valuable role of flexibility in regulating wholesale prices and reducing balancing mechanism costs will be taken into consideration. This is an important consideration in terms of how 'full-chain' flexibility is managed such that it delivers the maximum 'whole system' value at any given time.

Notwithstanding all the above, the emphasis on 'planning' needs to be qualified: the objective should not be to create a 'central planning' role but to establish an 'Energy Systems Architect' function whereby there is effective and commercially independent oversight and continuous review of an emergent fast-evolving energy systems architecture. This architecture will need to be continuously evaluated from the perspective of operational integrity, resilience and security (including supply and cyber security) - as well as from the perspective of ensuring the evolution of the energy system remains efficient, coordinated and economic. This approach should, given the appropriate (and essential) attention to energy governance reform, empower entrepreneurialism and innovation whilst allowing a managed but agile (rather than deterministic) evolution of the energy system, responsive to emerging challenges and opportunities.

#### **14. Are we considering the right organisation models for the FSO? And why?**

We believe the BEIS foreword to the consultation is correct in stating that the FSO would need to be independent of other commercial energy interests and from the day-to-day operational control of Government, also that it would need to be excellent in terms of technical expertise. The Ofgem foreword is also correct in our view in saying that the FSO should look holistically at long term electricity and gas challenges to support the transition to net zero and provide expert advice across the wider energy system on how to drive forward our net zero ambitions.

However, the proposal that the FSO should also manage the day-to-day operation of the electricity system is less compelling for the reasons we have stated above. Moreover, in terms of taking a stronger role in network planning (including planning of onshore and offshore electricity networks) and the introduction of competition in network solutions, the FSO/ESA should have oversight (rather than a direct planning role) which should extend to distribution as well as transmission networks. Similarly, in terms of a more active role in designing and planning the future (wider) energy system, the role should not displace the roles currently undertaken by TSOs and DNO/DSOs (similarly for gas transporters and network operators) as this would be impracticable for a central body. Rather the role should be one of an Energy Systems Architect (ESA) as outlined in our response to question 13 above. This stronger focus on strategic energy system development, divorced from the responsibilities for real-time system operation and detailed network design and planning undertaken by network operators, would be more likely to achieve the objective of a pioneering and coordinated approach to managing and planning the energy transition.

From an energy system planning and development perspective, an FSO/ESA would require a highly interactive relationship with TSOs and DSOs (and gas network operators) but also with wider energy system stakeholders generally (as depicted by the illustration in our covering letter to this response). This would need to be enabled through an agile governance structure and a flexible and iterative approach to strategic energy system development (from both a technology and markets perspective). This is fundamentally different to the model(s) which, however effectively, have served the energy industry and its customers to date. The temptation to continue to develop and adapt the current governance model through incrementalism is understandable given the criticality of the energy system and its infrastructure. However, the current model is unfit for purpose given the critical role of the energy system to delivering net zero and given the need for transformative change in the way a future integrated energy system will operate. Insofar as 'planning' remains a core function (across all timescales) it will be a far more responsive and agile form of planning wherein the evolution of the energy system is continuously evaluated and adapted.

Of the two options presented, our preference is towards a highly independent corporate body model classified within the public sector, but with operational independence from Government. This is based on our recommendation that the electricity 'System Operator' functions continue to be performed by an ESO (and DSOs) whether or not these 'SO' organisations remain under common ownership with (respectively) the transmission and distribution network operators.

We do not believe a profit-making organisation incentivised through its profit to drive performance is consistent with the strategic nature of the FSO/ESA role (where the energy system benefits are realised in the longer term). It will however be essential that the FSO/ESA organisation is adequately skilled to undertake the role and hence adequately funded to attract and retain the skills it will need. This means, amongst other things, its staff must be properly remunerated consistent with their skills and experience and with levels of remuneration and benefits they could reasonably expect to attract from the private sector.

**15. Are we considering the right elements for the FSO's regulatory and accountability frameworks? And why?**

This depends on the precise nature of the new FSO/ESA role and its relationship to Government, regulatory authorities, and the industry generally and, more fundamentally, where accountability for delivery will ultimately lie. We would refer to our responses to previous questions in this consultation with regard to the nature of the role we would see for an ESA (rather than an FSO). We would see the role as being an executive non-departmental public body, sponsored by BEIS but otherwise independent of both Ofgem and Government generally: not dissimilar to the role of the Committee on Climate Change with whom the FSO/ESA would necessarily have a close relationship as the 'architect' of an emergent net-zero compliant energy system. Where the role would differ from CCC in terms of responsibility and accountability is that we would see the FSO/ESA being responsible for overseeing delivery of a net-zero compliant whole energy system, including playing an active role in energy system governance.

**16. Do you have views on the level of shareholding or control involving other 'energy interests' and the FSO at which a conflict of interest would become a concern?**

As outlined in our response to question 15, we believe the FSO/ESA should be an executive non-departmental public body.

**17. Are we considering the right implications of our proposals for Elexon and Xoserve?**

We acknowledge that the ownership structure for the FSO/ENA may have implications for the ownership of Elexon and its subsidiaries, the Low Carbon Contracts Company (LCCC) and the Electricity Settlements Company. We agree there are no immediate implications for Xoserve as the Central Data Services Provider (CDSP) for the gas industry albeit in the longer term, there might be merit in reviewing the respective roles of Xoserve, Electralink and the Data Communications Company to consider whether the overall arrangements for management of metered energy data remain optimal.

However, as we explain in our response to questions 6 and 13, the more immediate imperative (which could have implications for Elexon's operating model) is the need to create a coordinated, integrated and transparent liquid electricity (and ultimately energy) market. This will be of particular importance for our future electricity system with high levels of weather-dependent renewable generation and extensive sources of flexibility (including through energy arbitrage). In principle, the concept would be to create an integrated market platform which would accommodate (and reconcile) wholesale markets, the balancing mechanism, ancillary services markets, the capacity market, and CfDs. The objective would be to ensure that the markets are acting (and interacting) in a way which optimises available resources and prices, and performing in the best interests of customers at all times.

**18. What is your view on the preferred implementation approach? Please explain why.**

We agree that some (but by no means all) of the capabilities (including the people, processes, systems and assets) needed to perform the proposed functions of the FSO or ESA as we would envisage it are already present within NGESO and NGG (but see our response to Q21). On the one hand it would be irresponsible to risk discontinuance of the existing functions of NGESO or NGG as a consequence of transfers between organisations of critical staff during the transition; on the other hand, a temporary duplication of roles during transition would be impractical. It follows that a phased transition is essential (but see our response to Q20 below).

**19. Based on the areas where we are considering new and enhanced roles and functions for the FSO, which of these should be prioritised for development? Please explain why.**

There is an inherent danger in a prioritised approach, which is that 'priority' areas receive attention in isolation to 'lower' priority areas in the mistaken belief that this will result in the most cost-effective approach to the required transformation. This is why our consultation response emphasises the need for a 'systems engineering' approach whereby re-engineering (including the overall governance) of the energy system is carried forward holistically. Only once the interdependencies are fully understood can 'prioritisation' be safely considered, and then only from a (pseudo) critical path perspective designed to achieve the ultimate transformation in a coordinated and timely fashion. Even so, given the required scale and pace of (and susceptibility to) change of the energy system, and the many future energy scenarios (and uncertainties) that may play out in our pursuit of net zero by 2050, the required new and enhanced functions may well also change over this timescale.

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It follows that the new and enhanced functions will need to remain continuously under review, which in turn means that the evolution of the FSO/ESA role will be subject to continuous change and adaptation. This cannot be achieved through 'prioritising' actions at the outset; rather the necessary development needs to be taken forward holistically with a comprehensive understanding of interactions and interdependencies and how these will emerge as the energy system evolves under different future energy scenarios. What will be important in any form of phased or incremental approach is to embed future-proofing at each stage of implementation in order not to create lock-in to any organisational design that might impede necessary future progression.

**20. What do you believe are the risks to implementation? How can these be mitigated?**

Whilst there is certainly a degree of urgency in implementing the FSO/ESA role, a carefully risk-managed, phased transition is essential with regular appraisals to ensure this does not result in discontinuity of any core functions. A risk-managed approach is required such that critical interactions and interdependencies are identified and adequately provided for during the transition. That said, it will be essential that the necessary skills, knowledge and experience are invested in the new FSO/ESA but not at the expense of the ESO role (this applies irrespective of whether the FSO/ESA retains responsibility for day-to-day operation of the system). We do not however underestimate the challenge of ensuring adequate skills are retained (and new skills developed) over the transition period; a comprehensive risk-managed approach will be necessary (please see our response to question 21 below).

**21. Do you have any comments on potential implications of implementation for you, your organisation, or other stakeholders?**

As a power systems consultancy there are no specific implications for ourselves (other than as a source of energy systems expertise). However, in respect of other stakeholders, the consultation appears not to fully consider the (essential) capabilities of DNO/DSOs and GDNs which currently lie outside NGESO and NGG and which will be essential in holistically performing many of the roles and functions proposed by the consultation for the FSO/ESA. Moreover, the additional roles proposed for an FSO/ESA by our response to this consultation will require some new or enhanced skills, processes and systems not currently present in any existing organisation. Not least of these requirements is a comprehensive systems engineering capability.

**22. What is your view on the position there are likely to be cost savings across the energy system from an increased "whole system" view, as described in paragraphs 47-52 of the IA? If so, is the potential magnitude of savings illustrated fairly in the IA? If not, why not?**

We are not in a position to comment on the quantum of the benefits illustrated in the IA but we agree that a whole energy system strategy is essential if synergies are to be maximised and conflicts avoided. This includes having an effective full-chain strategy for flexibility to ensure it delivers the maximum whole system value (including through supply and demand-side arbitrage) and this in turn requires the development of an integrated whole energy system market. In practice, the cost savings arising from an increased 'whole system' view (or strategy) might be difficult to track, but will no doubt be significant. However, the real 'cost' in economic (but also in environmental, health and welfare) terms of failing to deliver an integrated net zero-compliant energy system, whilst difficult to monetise, is likely to far exceed any unrealised 'system' cost savings. In that regard it is essential that the

imperative of delivering a net zero-compliant energy system is not put at risk by relying solely on short-term (or more easily monetised) economic considerations in the overall cost-benefit analysis.

**23. What is your view on the conclusion that policy intervention is likely to increase the benefits of onshore electricity network competition, as described in paragraphs 53-59 of the IA? If you agree, is the potential magnitude of savings illustrated fairly in the IA? If not, why not?**

Again, we are unable to comment on the quantum of the benefit illustrated in the IA but we agree that competition in provision and maintenance of energy networks can make an important contribution to overall cost-efficiency. However, this must not be at the expense of the objective of developing and maintaining an efficient, *coordinated* and economic whole energy system, which will be particularly important during a major energy transition. For example, piecemeal provision of electricity infrastructure (as a consequence of opening-up design and delivery to competition) runs the risk of creating ‘islanded’ (or suboptimal interconnection provision between) networks and/or the risk of insufficient futureproofing in respect of future demand, generation and energy storage growth. Similarly, failing to deliver energy infrastructure in a coordinated manner, for example by releasing independent contracts for infrastructure relating to different vectors without consideration of the potential cross-vector synergies, would potentially increase rather than save costs.

Developing and maintaining an efficient, coordinated and economic whole energy system requires evaluation of options both from a whole energy system perspective and also from a whole-life perspective (i.e. taking into account the economic lives of the assets concerned). This does not preclude competition (indeed competition in the actual provision and installation of infrastructure is already well established, as is competition in providing non-network alternative solutions) but increasing competition in planning and design of energy infrastructure and markets requires steps to ensure that planning and design remains holistic, taking a long-term perspective, and doesn’t become piecemeal with solutions based solely on short-term economics.

**24. Do you think that the impact assessment has identified and considered the key costs and benefits of policy intervention? If not, can you provide details on other impacts that have not been considered?**

We believe that an ESA (rather than FSO) role would deliver additional benefits and hence a higher overall present value. However, we are unable to quantify this in monetary (npv) terms.

**25. Do you think that the distribution of impacts is fairly represented, with impacted groups correctly identified? Outlined in table 5 of the IA.**

The overall distribution of impacts looks broadly reasonable given the FSO role proposed. However, again, we believe an ESA role would have a more positive impact from a whole energy system perspective.

- 26. We invite respondents' views on whether the proposals for energy system governance reform may have a different impact on people who have a protected characteristic (age, disability, gender re-assignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex or sexual orientation), in different ways from people who don't have that characteristic. Please provide any evidence that may be useful to assist with our analysis of policy impacts.**

The question highlights why the FSO/ESA needs to have oversight of the entire energy supply chain, including beyond the boundary meter. The priority here must be that low income, vulnerable and fuel poor individuals and households are sufficiently protected during the energy transition, particularly those for whom investments in digital and low carbon alternative technologies (e.g. heat and transport) might be prohibitively expensive or in some cases incomprehensible without support, as might be the up-front costs of energy efficiency measures and 'smart' technologies (including HEMS) that would deliver economic benefits in the longer term. In this regard, the need is for effective and trustworthy public communication, education and advice, and the intelligent use of subsidies and grants where appropriate.

The most effective way of addressing fuel poverty in many cases is to improve home thermal insulation levels (this will be of even greater importance for electric heating technologies such as heat pumps). Improved home energy efficiency will confer benefits throughout the entire energy supply chain by reducing demand and, in the case of electricity networks, reducing network technical losses (most of which vary with the square of electricity demand). In that regard, consideration should be given as to whether the current Energy Company Obligation (ECO) on energy suppliers is the most cost-effective way of delivering this objective. For example, were the obligation to be placed on DNOs to offer advice on energy efficiency and undertake measures to improve home thermal insulation levels, they would be in a better place to identify vulnerable customers through their local government and social housing association contacts within the communities they serve, and also through their future energy scenario studies which, inter alia, use socio-economic analysis to estimate future demand growth across their networks at a granular level. A further benefit would be that DNOs are generally able to raise capital at relatively low cost and depreciate (and therefore recover) expenditure over a period of up to 45 years<sup>10</sup> (broadly consistent with the lifespan of improved home thermal insulation measures) which in turn would reduce the impact on customers' energy bills.

In summary, ensuring effective mechanisms for identifying vulnerable and fuel-poor individuals and families, and for effective targeting of interventions, will be an important element of an FSO/ESA's remit. We would cite a recent initiative by UK Power Networks and the Energy Systems Catapult as a good example of using artificial intelligence to help achieve this objective<sup>11</sup>.

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<sup>10</sup> depending on companies' individual TOTEX capitalisation rates – typically 64-80%

<sup>11</sup> <https://es.catapult.org.uk/news/artificial-intelligence-project-to-help-people-facing-fuel-poverty/>